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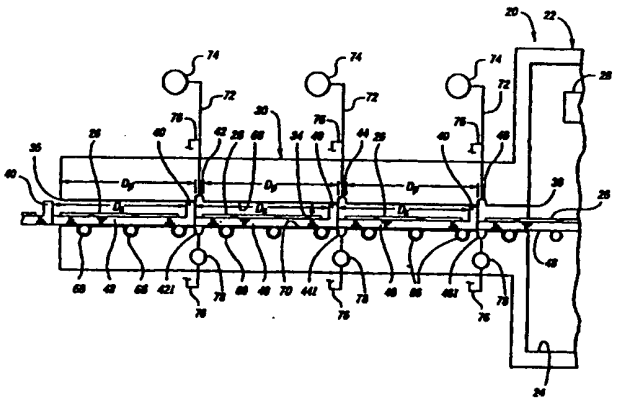

(57) Abstract

A processing system (20) and a method for processing discrete sheets (26) utilizes a housing (22) having an enclosed processing chamber (24) and at least one seal assembly which may be an ingress seal assembly (30) or an egress seal assembly (32). The seal assembly includes an elongated passage (34) of a uniform cross section and at least two seals (40) that are shaped to seal with the passage and being movable therethrough in a spaced relationship from each other along the length of the passage to permit at least one sheet to be received between the seals. An evacuation port (42) for drawing a vacuum within the passage (34) is provided at a location spaced from its outer end (36). When this spacing is a greater distance than the spacing between the seals (40), the vacuum is continuously drawn by the evacuation port (42). Second and third evacuation ports (44, 46) are provided to facilitate drawing of the vacuum at locations spaced successively inwardly from the next outer evacuation port (42, 44) by a distance greater than the spacing between the seals. Different embodiments are disclosed as including a carrier (48) connected to one seal (40), a carrier (48') connected to a pair of the seals (40), a processing mold (52) that can be carried by either carrier, and connectors (54) that extend between the seals. Rolls (66) are utilized to support the seals (40) for movement through the associated passage (34) in one embodiment, and in another embodiment the passage (34) of the seal assembly has a lower floor surface (70) along which the seals (40) are slidably moved through the passage.

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PROCESSING SYSTEM AND METHOD FOR PROCESSING DISCRETE SHEETS

TECHNICAL FIELD

This invention relates to a processing system and a method for processing discrete sheets within an enclosed chamber.

BACKGROUND ART

Processing systems for processing discrete sheets utilized in photovoltaics have previously incorporated load locks for introducing and delivering the sheets into and from a processing chamber. See, for example, the United States Patents of Foote et al: 5,248,349; 5,372,646; 5,470,397; and 5,536,333, all of which are assigned to the Assignee of the present application. See also United States Patent 4,797,054 Arii which discloses load locks utilized in discrete sheet processing. Operation of load lock systems involves moving parts that can cause reliability problems as well as being costly to install and operate. In addition, load lock systems have production output that is limited by the cycle time involved with opening and closing the load locks and drawing a vacuum during each cycle of operation. Such load locks also increase the length of the processing system and the factory space needed for operation which further increases the resultant cost of the processed glass sheets.

Sheet processing systems have also included slit type seals through which passage takes place into and out of system chambers such as disclosed by United States Patents: 2,384,500 Stoll; 3,057,792 Frohlich,

3,667,626 Torelli et al; 4,664,951 Doehler and 5,102,279 Ezaki et al.

DISCLOSURE OF INVENTION

One object of the present invention is to provide a discrete sheet processing system having an improved seal assembly through which the discrete sheets are passed into and/or out of an enclosed processing chamber.

In carrying out the above object, a processing system for processing discrete sheets in accordance with the invention includes a housing having an enclosed processing chamber in which the sheets are processed. A seal assembly of the system includes an elongated passage having an outer end communicated with the environment and an inner end communicated with the chamber. The elongated passage has a uniform cross section between its outer and inner ends. At least two seals of the seal assembly are shaped to seal within the passage and are movable therethrough in a spaced relationship from each other along the length of the passage to permit at least one sheet to be processed to be received between the seals. An evacuation port of the seal assembly draws a vacuum within the passage.

The evacuation port of the seal assembly is preferably at a location spaced from the outer end of the passage toward its inner end a greater distance than the spacing between the seals.

In the preferred construction of the processing system, the seal assembly further includes a second evacuation port for drawing a vacuum within the passage at a location spaced toward its inner end from

the first mentioned evacuation port a greater distance than the spacing between the seals. This preferred construction of the processing system also has the seal assembly further provided with a third evacuation port for drawing a vacuum within the passage at a location spaced toward its inner end from the second evacuation port a greater distance than the spacing between the seals.

The processing system is disclosed as having the seal assembly constructed as an ingress seal assembly through which the sheets are introduced into the chamber and is also disclosed as being an egress seal assembly through which the processed sheets are delivered from the chamber. As specifically disclosed, the seal assembly is an ingress seal assembly through which the sheets are introduced into the chamber and the system also includes an egress seal assembly through which the processed sheets are delivered from the chamber. More specifically, the sheets pass at opposite extremities of the chamber inwardly through the ingress seal assembly and outwardly through the egress seal assembly. The egress seal assembly has the same construction as the ingress seal assembly so as to include an elongated passage including an outer end communicated with the environment and an inner end communicated with the chamber and with the elongated passage having a uniform cross section between its outer and inner ends as well as having the seals shaped to seal within the passage of the egress seal assembly and being movable therethrough in a spaced relationship from each other along the length of the passage to permit at least one sheet to be received between the seals. An evacuation port of the egress seal assembly draws a vacuum within its passage and is preferably at a

location spaced from the outer end thereof a greater distance than the spacing between the seals.

The egress seal assembly also preferably includes a second evacuation port for drawing a vacuum within the passage thereof at a location spaced toward its inner end from its first mentioned evacuation port a greater distance than the spacing between the seals. Furthermore, the egress seal assembly also preferably includes a third evacuation port for drawing a vacuum at a location spaced toward its inner end from its second evacuation port a greater distance than the spacing between the seals.

In certain disclosed embodiments, the processing system includes a carrier located between the seals to support the sheet to be processed for conveyance through the passage of the seal assembly. This carrier construction is disclosed as having one end connected to one seal and is also disclosed as having opposite ends connected to a pair of the seals. In addition, the carrier is disclosed as including a mold for supporting the sheet during the processing.

Other embodiments of the processing system are disclosed as including at least one connector extending between the seals. The connector in certain embodiments is disclosed as being rigid and as including a pair of rigid members that are unitary with at least one seal. In addition, one embodiment discloses a plate member having a central opening and including leading and trailing ends that define a pair of the seals and also including opposite lateral sides that define the pair of rigid connectors.

The connector extending between the seals is also disclosed as being flexible and is specifically disclosed with a pair of the flexible connectors extending between the seals.

Different embodiments of conveyance are disclosed as part of the processing system. In one embodiment which is the preferred one, the seal assembly includes rolls that support the seals for movement through the passage. In another embodiment, the passage of the seal assembly has a lower surface along which the seals are slidably moved through the passage.

Another object of the present invention is to provide an improved method for processing discrete sheets within an enclosed housing chamber.

In carrying out the above object, the method is performed by positioning a discrete sheet to be processed between a pair of spaced seals that are shaped to seal within an elongated passage having a uniform cross section between an outer end thereof adjacent the environment and an inner end thereof adjacent an enclosed housing chamber. The method is performed by moving the discrete sheet and the pair of seals through the elongated passage and by drawing a vacuum within the passage at an evacuation port spaced from the outer end thereof toward its inner end.

The vacuum is preferably drawn within the evacuation port at a location spaced from the outer end thereof toward its inner end by a greater distance than the spacing between the seals.

In the preferred practice, the method is performed by moving a second discrete sheet through the

elongated passage adjacent the first mentioned discrete sheet and between an associated pair of seals that are shaped to seal within the passage and spaced from each other the same distance as the spacing between the pair of seals associated with the first mentioned discrete sheet. This preferred practice of the method also includes drawing a vacuum within the passage at a second evacuation port spaced toward the inner end of the passage from the first mentioned evacuation port a greater distance than the spacing between the seals.

Furthermore, the most preferred practice of the method also involves moving a third discrete sheet through the elongated passage adjacent the second discrete sheet and between an associated pair of seals that are shaped to seal within the passage and spaced from each other the same distance as the spacing between the pair of seals associated with the second discrete sheet. In addition, this most preferred practice of the method also is performed by drawing a vacuum within the passage at a third evacuation port spaced toward the inner end of the passage from the second evacuation port a greater distance than the spacing between the seals.

BRIEF DESCRIPTION OF DRAWINGS

FIGURE 1 is a partially broken away side elevation view of a discrete sheet processing system having a housing in which the sheets are processed and both ingress and egress seal assemblies constructed in accordance with the invention and operable to perform the method of the invention.

FIGURE 2 is a sectional view taken along the direction of line 2-2 in FIG. 1 through the ingress seal assembly at the left end of the housing and is also

illustrative of the egress seal assembly located at the right end of the housing.

FIGURE 3 is an elevation view taken in section through the ingress seal assembly along the direction of line 3-3 in FIG. 2.

FIGURE 4 is an elevational view taken in section through the egress seal assembly in the same direction as the ingress seal assembly illustrated in FIG. 3.

FIGURE 5 is a view that illustrates one embodiment of a seal and an associated carrier that is movable through the seal assembly in a sealed relationship and that is also disclosed as having a carrier which is illustrated with a mold that provides support of the sheet during the processing involved.

FIGURE 6 is a view similar to FIG. 5 of another embodiment of a carrier for the sheet to be processed and is disclosed as having opposite ends which include a pair of the seals.

FIGURE 7 is a view that illustrates another embodiment of the seals wherein at least one connector extends between the seals and has a rigid construction.

FIGURE 8 is a perspective view that illustrates a plate member constructed to include a pair of seals and a pair of rigid lateral connectors that cooperatively define an open center in which the discrete sheet to be processed is conveyed over the rollers illustrated.

FIGURE 9 is a view similar to FIG. 7 showing a pair of the seals and at least one connector extending between the seals with a flexible construction.

FIGURE 10 is a view taken in the same direction as FIGS. 3 and 4 to illustrate another embodiment wherein the seal and associated carrier are slidably moved through the associated passage rather than being moved on conveyor rolls.

BEST MODES FOR CARRYING OUT THE INVENTION

With reference to FIG. 1 of the drawings, a processing system 20 illustrated is constructed in accordance with the present invention and is operable to perform the method thereof such that both aspects of the invention will be described in an integrated manner with each other. System 20 includes a housing 22 defining an enclosed processing chamber 24 in which discrete sheets 26 are processed. For example, the discrete sheets may be glass sheets on which semi-conductor material is deposited by deposition apparatus 28 such as disclosed by the previously mentioned Foote et al patents to provide photovoltaic devices. The deposition may be on any type of discrete sheets such as glass or metal, etc. At the left end of the housing, the system 20 includes an ingress seal assembly 30 though which the sheets 26 are introduced into the enclosed chamber 24 for the processing. At its right end, the system 20 includes an egress seal assembly 32 through which the processed sheets 26 pass outwardly from the housing chamber 24.

With reference to FIG. 2 which is illustrative of the cross-sections of each of the seal assemblies and with reference to both FIGS. 3 and 4 that respectively illustrate the ingress seal assembly 30 and the egress

seal assembly 32, each of the seal assemblies includes an elongated passage 34 having an outer end 36 that is communicated with the environment and having an inner end 38 communicated with the housing chamber 24 in which the sheets 26 are processed. Each elongated passage 34 has a uniform cross section illustrated in FIG. 2 between its outer and inner ends 36 and 38 shown in FIGS. 3 and 4. At least two seals 40 are provided and shaped to seal within the passage 36 and are movable therethrough in a spaced relationship from each other along the length of the passage to permit at least one sheet 26 to be processed to be received between the seals. It should be appreciated that it is also possible to position two or more sheets 26 between each adjacent pair of seals 40 spaced longitudinally along the direction of conveyance, laterally along the direction of conveyance or both longitudinally and laterally along the direction of conveyance as may be most convenient. The spacing of the seals 40 from each other is at a distance D_s as illustrated for both the ingress seal assembly 30 and the egress seal assembly 32. A first evacuation port 42 of each seal assembly is provided for drawing a vacuum within the associated passage 34 at a location spaced from the outer end 36 thereof by a distance D_p that is preferably greater than the spacing distance D_s between the seals 40.

The seals 40 are relatively closely spaced to the passage 34 leaving only a total spacing of about less than 0.005 to 0.040 of an inch above and below the seal and a total space of 0.005 to 0.040 of an inch on the sides of the seal, even though this spacing is illustrated much greater for purposes of illustration in the drawings. Due to the relatively small spacing between the seals 40 and the passage 34, a vacuum can be maintained in the processing chamber 24. When the

longitudinally spacing between the seals by the distance D_s is not less than the spacing by the distance D_p between the first evacuation port 42 and the outer end of the passage 36, the evacuation port 42 will only draw a vacuum when both adjacent seals 40 are within the passage 36. However, when the longitudinally spacing between the seals by the distance D_s is less than the spacing by the distance D_p between the first evacuation port 42 and the outer end of the passage 36, there is always one seal between the evacuation port that draws the vacuum and the environment and only a relatively small amount of gas can thus be enter into the location between the two seals 40 adjacent the passage outer end 36. This enables the seal assemblies to maintain a contained environment within the housing chamber 24 which may be a vacuum drawn by a vacuum pump 43 (FIG. 1) in which semiconductor gases are introduced for deposition on the sheets 26. When heating is involved, it is important for the seals 40 to have thermal stability so as to not warp and thereby disrupt the close tolerance spacing that minimizes the gas flow between the seals and the passage 34 while still permitting movement along the passage as previously described. Materials that are useful in this regard are graphite and sinter bonded fused silica particles.

As illustrated in FIGS. 3 and 4, each of the ingress and egress seal assemblies 30 and 32 also includes a second evacuation port 44 spaced toward its inner end 38 from the first evacuation port 42 by a distance D_p that is greater than the spacing by the distance D_s between the seals 40. As such, the second evacuation port 44 is always isolated by one of the seals 40 from the vacuum being drawn by the first evacuation port 42. Furthermore, each of the ingress and egress seal assemblies 30 and 32 also preferably

includes a third evacuation port 46 for drawing a vacuum within the passage 34 at a location spaced toward its inner end 38 from the second evacuation port 44 by a greater distance D_p than the spacing by the distance D_s between the seals 40. As such, there is always one seal 40 between the third evacuation port 46 and the vacuum being drawn by the second evacuation port 44.

With both the ingress seal assembly 30 and the egress seal assembly 32 having the construction described above wherein the vacuum is drawn at three stages, it is possible to efficiently maintain a relatively low level of vacuum for processing. Specifically, each stage of vacuum can readily reduce the pressure to one tenth or less of the prior pressure such that the three stages can reduce the pressure to less than one thousandth of an atmosphere or so, and efficient operating conditions at below ten torr of vacuum can be maintained.

With reference to FIG. 5, the preferred embodiment as disclosed in FIGS. 1-4 includes a carrier 48 for carrying the sheet 26 to be processed and has one end 50 connected to one seal 40 with the sealing at the opposite end being done by the seal of the adjacent carrier. As illustrated in FIG. 6, the carrier 48' has opposite ends 50 connected to a pair of the seals 40 which allows the carrier to be switched end for end. Also, it is possible for either carrier to have a mold 52 as illustrated in FIG. 5 on which the sheet 26 is supported in order to provide forming of the sheet during the processing as it is heated within a heated environment in the housing chamber. Furthermore, with the construction illustrated, it is also possible for the mold to support a previously formed sheet that may be bent both longitudinally and/or laterally with

respect to the direction of conveyance since the seals 40 have a greater height than the carrier and can accommodate such a shape.

With reference to FIGS. 7, 8 and 9, different seal embodiments are disclosed with each including at least one connector 54 extending between the seals 40. In the FIG. 7 embodiment, each connector 54 is a rigid connector and there are a pair of such connectors spaced laterally to facilitate the movement of the seals 40 through the associated passage. The connectors 54 can be fixedly connected to the seals 40 at one or both ends or can simply be positioned between the seals with their ends received within suitable holes in the seals if the seals are pushed through the passage. In the embodiment of FIG. 8, there are a pair of rigid connectors 54 that are unitary with at least one seal 40. As specifically illustrated, a plate member 56 has a central opening 58 and includes leading and trailing ends 60 and 62 that define a pair of the seals 40 as well as including opposite lateral sides 64 that define the pair of rigid connectors 54. With this embodiment, the sheet to be processed can be conveyed within the central opening 58 on rolls 66 as is hereinafter more fully described. In the embodiment of FIG. 9, a flexible connector 54 is disclosed and there are a pair of such flexible connectors such as cables that permit the seals to be fixedly secured thereto and readily pulled through the system for the processing.

In the embodiments of FIGS. 7 and 9, it is possible for the sheet being processed to be conveyed on rolls like with the embodiment of FIG. 8 and it is also possible for the connectors 54 to support the sheet being processed.

With reference to FIGS. 3 and 4, the ingress and egress seal assemblies 30 and 32 each includes roll 66 that convey the seals 40 and their associated carriers 48 through each associated passage 34 below its upper ceiling 68 where the evacuation ports 42, 44 and 46 are located. With such a construction, there is also a spacing between the seals 40 and the carriers 48 at the passage floor 70 where each of the evacuation port is provided with a lower portion 42_1, 44_1 and 46_1 that are spaced in the same manner previously described in connection with the upper evacuation ports. Furthermore, as illustrated in FIG. 2, each of the upper evacuation ports such as the evacuation port 42 illustrated is connected by an associated conduit 72 to an associated vacuum pump 74. In addition, each of the lower evacuation ports such as the lower evacuation port 42_1 illustrated is connected by a conduit 76 to the vacuum pump 74 that is connected to its associated upper vacuum port. A control valve 78 is also provided to adjust as necessary the vacuum drawn above and below the discrete sheets being conveyed through the seal assembly. It should also be appreciated that it is possible to utilize dual upper and lower vacuum pumps and a control operator to provide such a vacuum control. Furthermore, as previously mentioned, the construction illustrated in FIG. 2 with respect to the evacuation port 42 and its lower evacuation port 42, is also applicable to each of the other evacuation ports 44, 44_1 and 46, 46_1.

With reference to FIG. 10, another embodiment is disclosed as having the passage 34 of the seal assembly provided with a lower floor or surface 70 along which the seals 40 are slidably moved through the passage. In this embodiment, there is no spacing between the seals 40 and the floor surface 70.

Upon drawing of the vacuum by each of the vacuum pumps 74 at each of the three stages, it is preferable for the vacuum drawn to be maintained at the suction side at a pressure that is less than 0.53 times the pressure on the other side of the associated seal 40. More specifically, maintaining the vacuum drawn below that extent produces a shock wave since gases will not travel faster than the speed of sound and the net effect is that efficiency in pumping and maintaining the relatively low vacuum is achieved as described above.

While the best modes for carrying out the invention have been described in detail, those familiar with the art to which this invention relates will recognize various alternatives, designs, embodiments and ways for carrying out the invention as defined by the following claims.

WHAT IS CLAIMED IS:

1. A processing system for processing discrete sheets, comprising:

a housing having an enclosed processing chamber in which the sheets are processed; and

a seal assembly including an elongated passage having an outer end communicated with the environment and an inner end communicated with the chamber, the elongated passage having a uniform cross section between its outer and inner ends, at least two seals that are shaped to seal within the passage and that are movable through the passage in a spaced relationship from each other along the length of the passage to permit at least one sheet to be received therebetween, and an evacuation port for drawing a vacuum within the passage.

2. A processing system as in claim 1 wherein the evacuation port within the passage is at a location spaced from the outer end thereof a greater distance than the spacing between the seals.

3. A processing system as in claim 2 wherein the seal assembly further includes a second evacuation port for drawing a vacuum within the passage at a location spaced toward its inner end from the first mentioned evacuation port a greater distance than the spacing between the seals.

4. A processing system as in claim 3 wherein the seal assembly further includes a third evacuation port for drawing a vacuum within the passage at a location spaced toward its inner end from the second evacuation port a greater distance than the spacing between the seals.

5. A processing system as in claim 1, 2, 3 or 4 wherein the seal assembly is an ingress seal assembly through which the sheets are introduced into the processing chamber.

6. A processing system as in claim 1, 2, 3 or 4 wherein the seal assembly is an egress seal assembly through which the sheets are delivered from the processing chamber after the processing.

7. A processing system as in claim 1, 2, 3 or 4 wherein the seal assembly is an ingress seal assembly through which the sheets are introduced into the processing chamber and the system further including an egress seal assembly through which the sheets are delivered from the processing chamber after the processing, the egress seal assembly having an elongated passage including an outer end communicated with the environment and an inner end communicated with the chamber, the elongated passage of the egress seal assembly having a uniform cross section between its outer and inner ends, the seals being shaped to seal within the passage of the egress seal assembly and being movable therethrough in a spaced relationship from each other along the length of the passage of the egress seal assembly to permit at least one sheet to be received therebetween, and an evacuation port for drawing a vacuum within the passage of the egress seal assembly.

8. A processing system as in claim 7 wherein the evacuation port of the egress seal assembly is at a location spaced from the outer end thereof a greater distance than the spacing between the seals.

9. A processing system as in claim 8 wherein the egress seal assembly further includes a second

evacuation port for drawing a vacuum within the passage thereof at a location spaced toward its inner end from its first mentioned evacuation port a greater distance than the spacing between the seals.

10. A processing system as in claim 9 wherein the egress seal assembly further includes a third evacuation port for drawing a vacuum at a location spaced toward its inner end from its second evacuation port a greater distance than the spacing between the seals.

11. A processing system as in claim 1 which includes a carrier located between the seals to support the sheet for conveyance through the passage of the seal assembly.

12. A processing system as in claim 11 wherein the carrier has one end connected to one seal.

13. A processing system as in claim 11 wherein the carrier has opposite ends connected to a pair of the seals.

14. A processing system as in claim 11 wherein the carrier includes a mold for supporting the sheet during the processing.

15. A processing system as in claim 1 which includes at least one connector extending between the seals.

16. A processing system as in claim 15 wherein the connector is rigid.

17. A processing system as in claim 16 which includes a pair of the rigid connectors.

18. A processing system as in claim 17 wherein the pair of rigid connectors are unitary with at least one seal.

19. A processing system as in claim 18 which includes a plate member having a central opening and including leading and trailing ends that define a pair of the seals and also including opposite lateral sides that define the pair of rigid connectors.

20. A processing system as in claim 15 wherein the connector is flexible.

21. A process system as in claim 20 which includes a pair of the flexible connectors.

22. A processing system as in claim 1 wherein the seal assembly includes rolls that support the seals for movement through the passage.

23. A processing system as in claim 1 wherein the passage of the seal assembly has a lower surface along which the seals are slidably moved through the passage.

24. A method for processing discrete sheets comprising:

positioning a discrete sheet between a pair of spaced seals that are shaped to seal within an elongated passage having a uniform cross section between an outer end thereof adjacent the environment and an inner end thereof adjacent an enclosed housing chamber;

moving the discrete sheet and the pair of seals through the elongated passage; and

drawing a vacuum within the passage at an evacuation port spaced toward the inner end thereof from its outer end.

25. A method for processing discrete sheets as in claim 24 wherein the vacuum is drawn within the evacuation port at a location spaced toward the inner end thereof from the outer end a greater distance than spacing between the seals.

26. A method for processing discrete sheets as in claim 23 and further comprising:

moving a second discrete sheet through the elongated passage adjacent the first mentioned discrete sheet and between an associated pair of seals that are shaped to seal within the passage and spaced from each other the same distance as the spacing between the pair of seals associated with the first mentioned discrete sheet; and

drawing a vacuum within the passage at a second evacuation port spaced toward the inner end of the passage from the first mentioned evacuation port a greater distance than the distance between the seals.

27. A method for processing discrete sheets as in claim 26 and further comprising:

moving a third discrete sheet through the elongated passage adjacent the second discrete sheet and between an associated pair of seals that are shaped to seal within the passage and spaced from each other the same distance as the spacing between the pair of seals associated with the second discrete sheet; and

drawing a vacuum within the passage at a third evacuation port spaced toward the inner end of the

passage from the second mentioned evacuation port a greater distance than the distance between the seals.

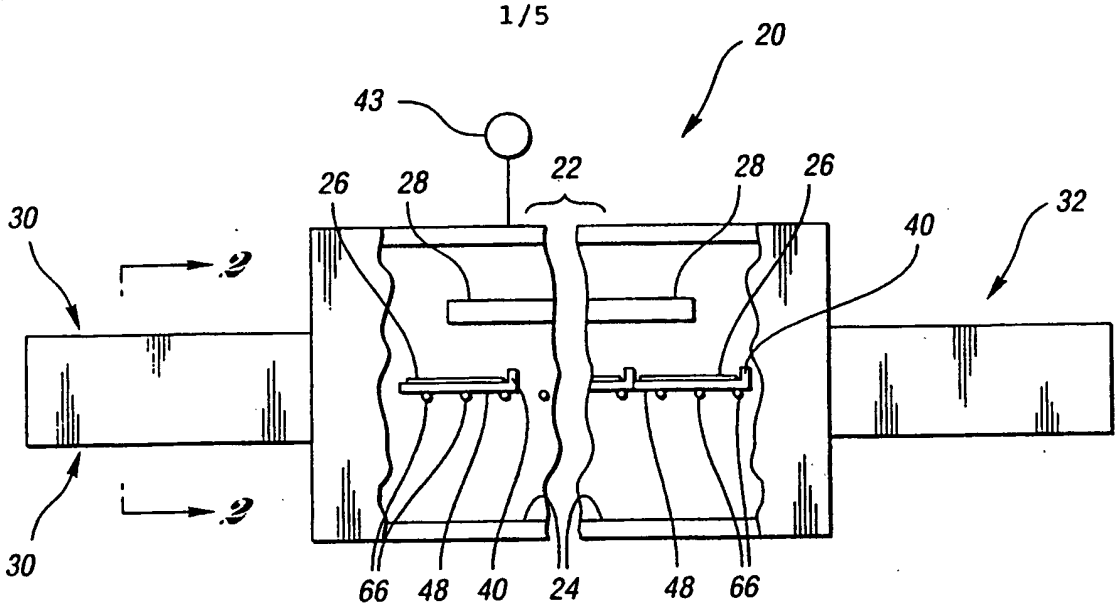
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Fig. 1

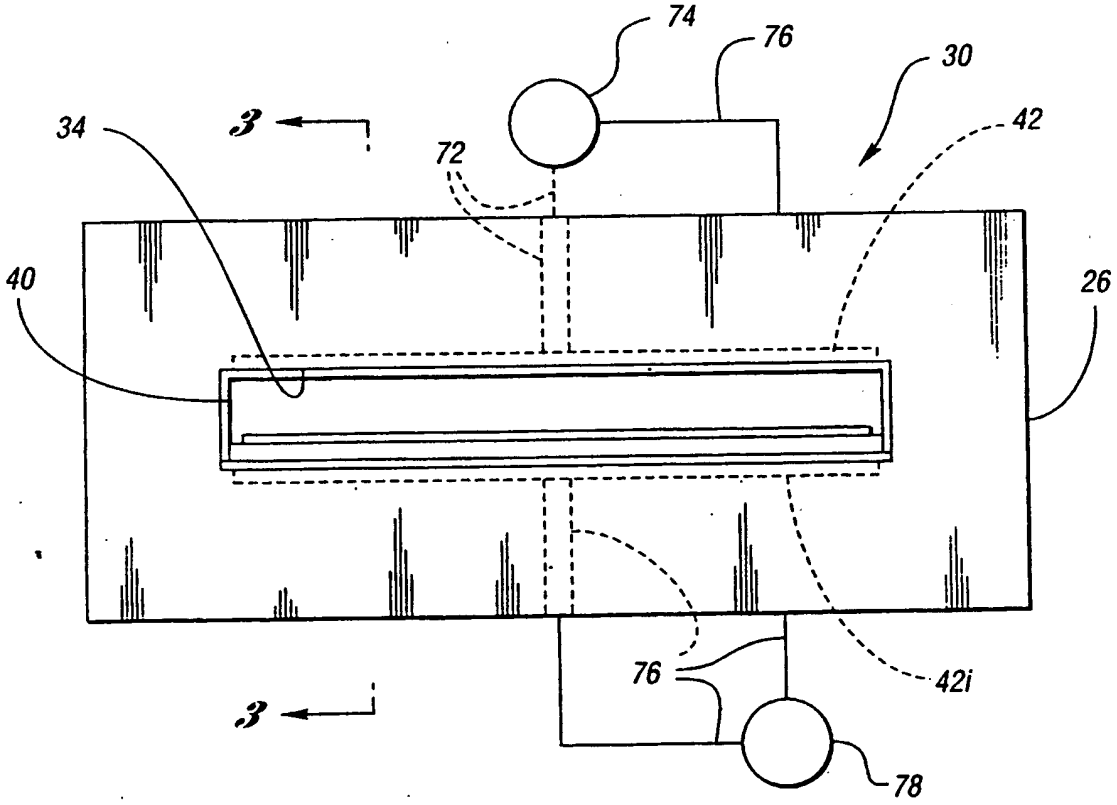
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Fig. 2

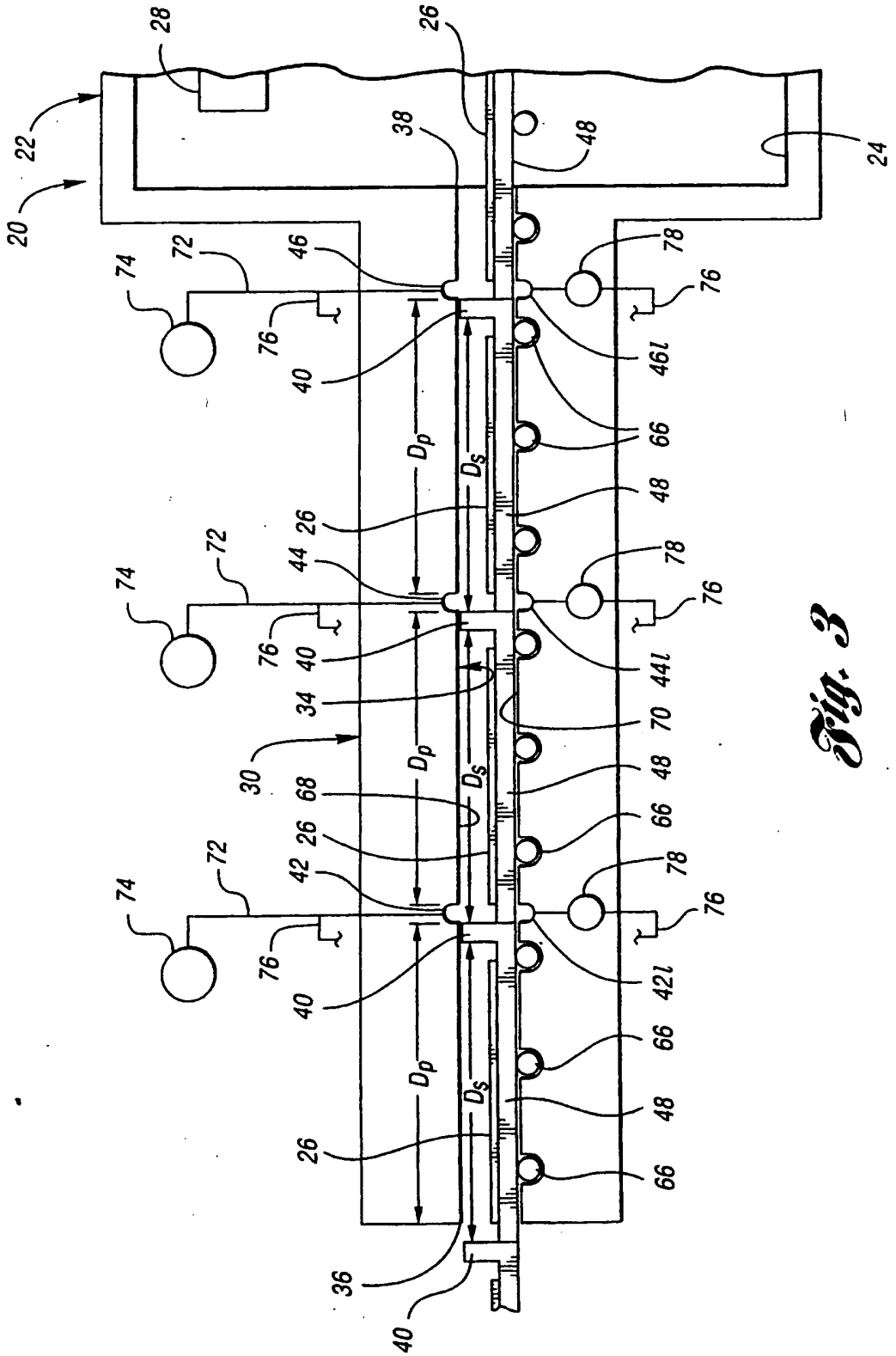
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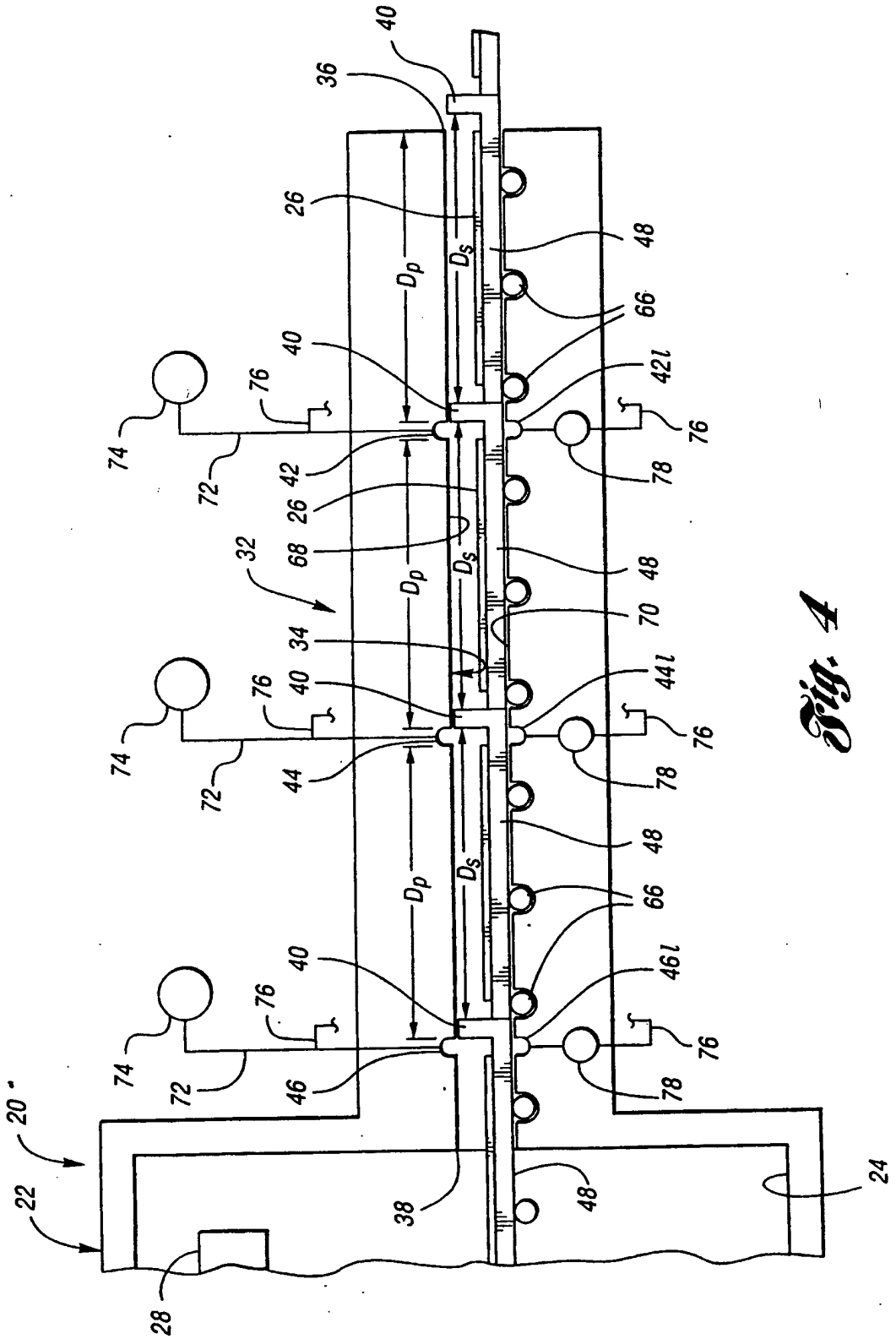
Fig. 3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36
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48
D_p
D_s
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74
42l
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46l
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28

Fig. 4

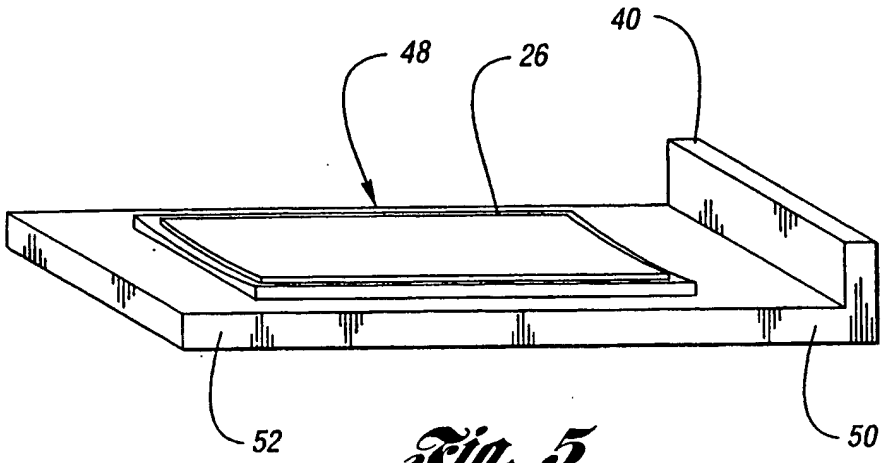

Fig. 5

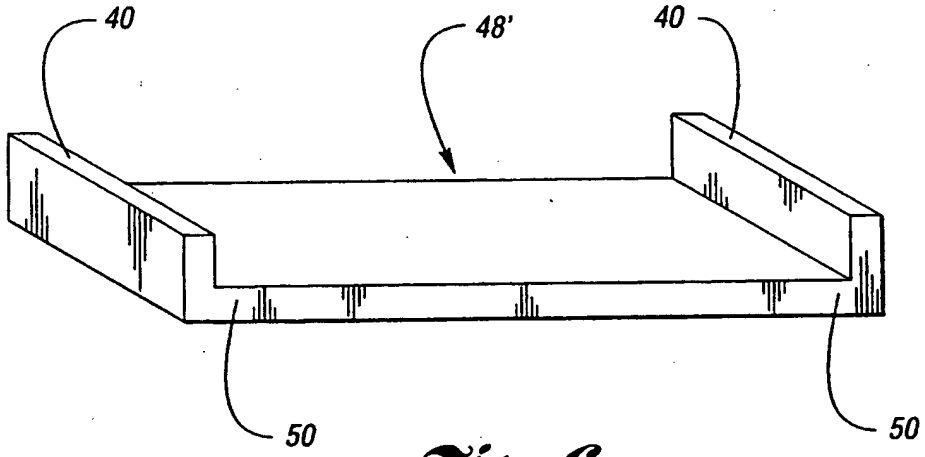

Fig. 6

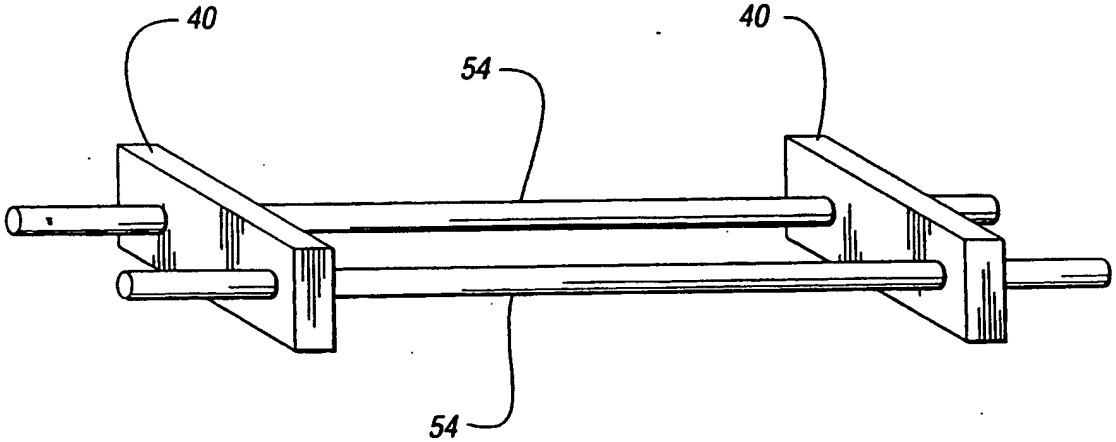

Fig. 7

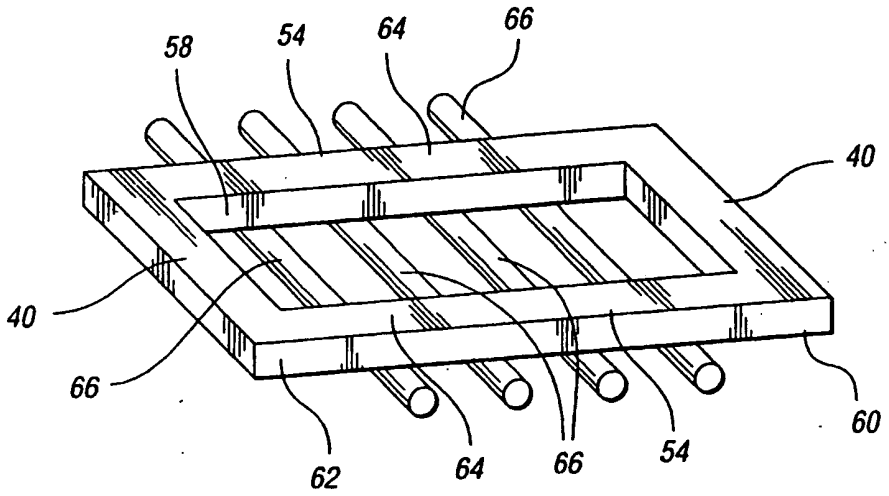

Fig. 8

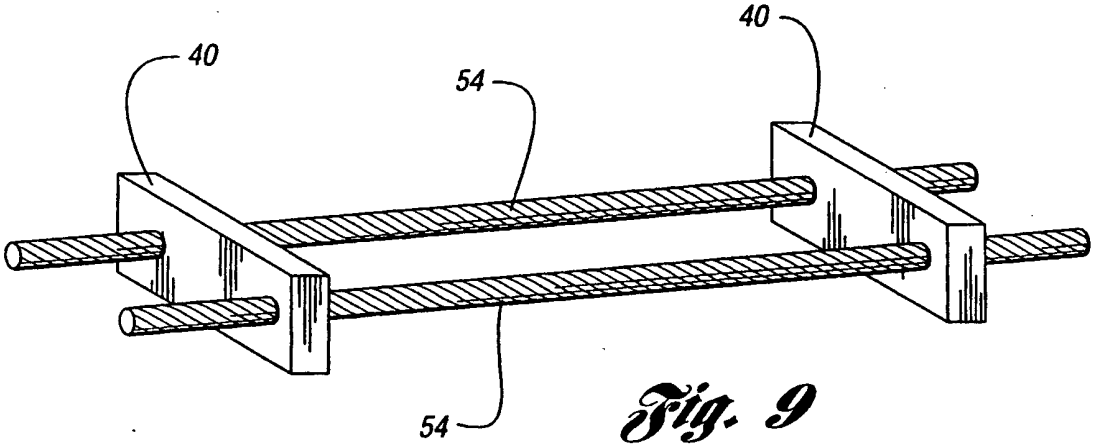

Fig. 9

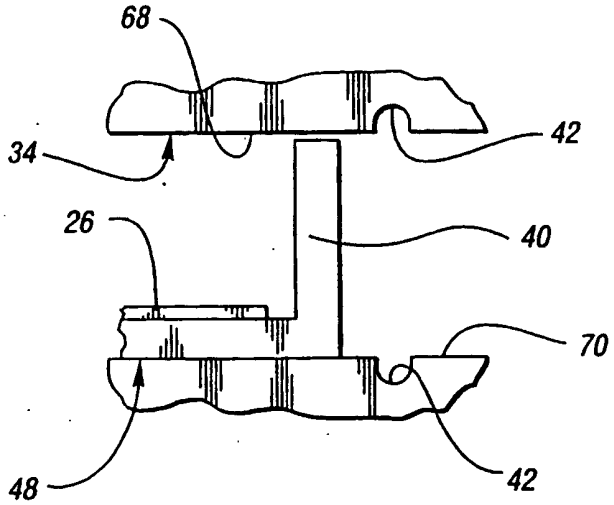

Fig. 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/20727

A. CLASSIFICATION OF SUBJECT MATTER
IPC(6) :C23C 16/54
US CL :414/217
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
U.S. : 414/217

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,382,126 A (HARTIG et al) 17 January 1995, col. 4, lines 4-9.	1-27
Y	US 4,812,101 A (GEORGE et al) 14 March 1989, col. 2, lines 42-46.	1-27

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search 24 FEBRUARY 1998	Date of mailing of the international search report 10 APR 1998
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer THOMAS J. BRAHAN Telephone No. (703) 308-1113

Form PCT/ISA/210 (second sheet)(July 1992)★